

TEACHER EVENT CHECKLIST

CAUTION: FALLING EVERYTHING! EXPEDITION (MICROGRAVITY)

Date Completed	PRE EVENT REQUIREMENTS
	1. Print out 1 copy each of this entire .pdf file (color copy preferred). Please note: this document is 21 pages long.
	2. Sign Agreement to Participate and fax to the Distance Learning Outpost at (281) 483-3789 within 3 business days of confirmation.
	3. Have students take Pre-Event Quiz on page 6.
	4. Complete all pre-event activities on pages 5-19 with the students.
	5. Teacher to fax or E-mail (preferred) student's questions to our office no later than 3 business days prior to your event date (see page 5).
	6. Review NASA Event Guidelines on page 20.
	DAY OF EVENT ACTIVITIES
	1. The students will be asked to share their results from their pre-work activities with the NASA DLO presenters.
	2. Bring any appropriate classroom projects or materials to support student presentations.
	POST EVENT REQUIREMENTS
	1. Have students to take Post-Event Quiz to demonstrate knowledge of subject.
	2. Teacher(s) and students to fill out event feedback , see page 21.
	3. Distance Learning Outpost will respond to any follow-up questions.
	4. Students to complete extended activities on page 21 at Teacher's discretion.

**Teacher(s) Agreement To Participate
NASA Johnson Space Center
Distance Learning Outpost**

I have reviewed the Learning Module and agree to complete all of the required activities with my students, both prior to, and following, the video teleconferencing event.

Teacher(s)

School/Institution

Event #

Date of Event

Microgravity 5-8

Instructional Goal:

Upon completion of this learning module, students will be able to explain the concept of microgravity and describe the benefits of microgravity research.

Learning Objectives:

1. Students will be able to explain what microgravity is and how it can be created.
2. Students will be able to compare and contrast activities in a gravity environment with similar activities in a microgravity environment.
3. Students will be able to describe and explain the benefits of microgravity research.

National Education Standards

Science (NSTA)

Physical Science - *Motions and Forces*

Math (NCTM)

Algebra – *Patterns and mathematical models*
Measurement

Texas Essentials Knowledge and Skills (TEKS)

Science:

6th grade: 6.A, 6.B

7th grade: 7.6A

8th grade: 7.A

Math:

6th grade 2.B&C, 4.A, 8.B&D, 12.A

7th grade: 2.B,D,G; 4.B, 7.9, 14.A, 15.A&B

8th grade: 8.2.B,C,D ; 8.4; 5.A,B; 15.A; 16.A&B



Grade Level:

Grades 5-8

Time requirements:

1 class activity to research definitions

2 class activities to perform pre-event activities

1 – Fifty (50) minute video teleconference

Students will be sharing their results and experiences during the NASA DLO event.

OVERVIEW

Often misperceived as weightlessness or zero gravity, microgravity is the unique gravitational environment astronauts experience on a spacecraft orbiting the earth. It is a condition that challenges humans who work and live in space, and that benefits many types of scientific research by freeing it from restrictions imposed by Earth's gravity for thousands of years.

Once students are familiar with the basics of microgravity, they will connect to the NASA Johnson Space Center for a live interactive video teleconference. During the videoconference, students will learn through real-time interactive demonstrations how certain scientific principles are altered in the microgravity environment. They will learn how scientists will use the microgravity of space to open a new era of scientific discovery that will have important implications for life on Earth.

NATIONAL EDUCATION STANDARDS ADDRESSED

Science Grades 5-8

Physical Science *Motions and Forces*

- The motion of an object can be described by its position, direction of motion, and speed. That motion can be measured and represented on a graph
- An object that is not being subjected to a force will continue to move at a constant speed and in a straight line.
- If more than one force acts on an object along a straight line, then the forces will reinforce or cancel one another, depending on their direction and magnitude. Unbalanced forces will cause changes in the speed or direction of an object's motion.

(Note: The study of motions and the forces causing motion provide concrete experiences on which a more comprehensive understanding of force can be based in grades 9-12. By using simple objects, such as rolling balls and mechanical toys, students can move from qualitative to quantitative descriptions of moving objects and begin to describe the forces acting on the objects. Students' everyday experience is that friction causes all moving objects to slow down and stop. Through experiences in which friction is reduced, students can begin to see that a moving object with no friction would continue to move indefinitely, but most students believe that the force is still acting if the object is moving or that it is "used up" if the motion stops. Students also think that friction, not inertia, is the principle reason objects remain at rest or require a force to move. Students in grades 5-8 associate force with motion and have difficulty understanding balanced forces in equilibrium, especially if the force is associated with static, inanimate objects, such as a book resting on the desk.)

Math Grades 6-8

Algebra *Understand patterns, relations, and functions.*

Represent, analyze, and generalize a variety of patterns with tables, graphs, words, and when possible, symbolic rules.

Use mathematical models to represent and understand quantitative relationships.

Model and solve contextualized problems using various representations, such as graphs, tables, and equations.

INSTRUCTIONAL STRATEGY

Pre-VTC Classroom Component

Class Activity #1

1. Students to take [Pre-Event Quiz](#) on page 6 to test their knowledge prior to these lessons about Microgravity. Students keep these quizzes on file to compare to their [Post-Event Quiz](#), also on page 6.
2. Students answer the questions on the worksheet on page 8, [Pre-Event Research](#). This worksheet contains mostly terminology that will be helpful during the event.

The following web sites offer information about microgravity that you may find useful in this exercise:

What is microgravity?

http://www.lerc.nasa.gov/Other_Groups/PAO/html/microgex.htm

Understanding Microgravity

<http://mgnews.msfc.nasa.gov/db/understanding Ug/understanding Ug.html>

Microgravity Science Overview

http://science.nasa.gov/msl1/themes/micrograv_over.htm

Other Resource

<http://spacelink.nasa.gov/Instructional.Materials/Curriculum.Support/Physical.Science/Microgravity/index.html>

Class Activity #2

1. Students perform Inertial Balance experiment. The description of this activity and its associated handouts are at [Inertial Balance Activity](#) on pages 9-14. The students may build their own inertial balances or the teacher may build a class set of inertial balances before performing this activity. **Students will be asked to share their data and experiences during the DLO event.**

Class Activity #3

1. Students perform [Water Observation Activity](#) on page 15 and the [Flame Observation Activity](#) on page 16. These activities will allow the students to investigate water properties and candle flame properties in a gravity environment. This data will be used to compare and contrast their properties in a microgravity environment. **Students will be asked to share their data and experiences during the DLO event.**

Class Activity #4

1. Make the [Ball and Cup Activity](#) on pages 17-19 and do the Earth experiments. The follow-up activity showing how this experiment went in space will be covered during the DLO event. **Students will be asked to share their data and experiences during the DLO event.**
2. As a class, develop at least 5 questions associated with microgravity that you would like to ask during the video teleconference and E-mail them to us at DLO1@jsc.NASA.gov or fax them to us at (281) 483-3789 at least 3 business days prior to your scheduled connection time.

Pre/Post Event Quiz

- 1) What is the definition of microgravity?
- 2) Describe an object in microgravity and contrast its behavior in microgravity with its behavior in a gravity environment.
- 3) How do you determine the weight of something in space?
- 4) Why is it important to do research in a microgravity environment?
- 5) What are some of the benefits of this space based research for us on earth?

Suggested answers for Pre-Event Quiz/Post-Event Quiz--Please do not share with the students. Answers should be similar to:

- 1) An environment in which the apparent weight of a system is small to its actual weight due to gravity.
- 2) It does not fall to the ground. Convection missing – hot air doesn't rise.
- 3) Based on mass of the item. Correlated and interpreted into weight on Earth.
- 4) We cannot simulate microgravity on earth --- can't reduce convection and sedimentation
- 5) Crystal Growth – pharmaceuticals
Materials --- metals more pure in form
Combustion
Health – body reactions

Pre-Event Research

1. Write an explanation of each of the following terms, in your own words.

Free fall

Gravity

Inertia

Mass

Microgravity

Weight

3. What areas of research are being performed in microgravity? (List 4 of the 5)

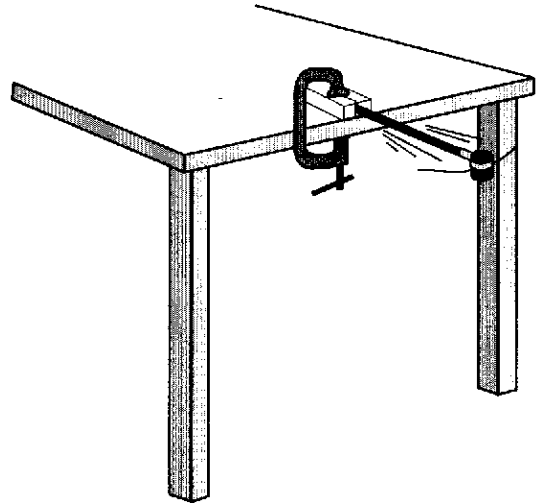
Inertial Balance Activity

Objective:

- To demonstrate how mass can be measured in microgravity.

Materials and Tools:

- Hacksaw blade (12 inch)
- Coping saw (optional)
- 1 C-clamp (optional)
- Plastic 35 mm film canister
- Tissue paper
- Masking tape
- Wood block (1 x 2.5 x 4 inch)
- Wood saws
- Glue
- Objects to be measured
- Graph paper, ruler, and pencil
- Pennies and nickels
- Stopwatch



Objects of unknown mass are measured with a balance that works in microgravity.

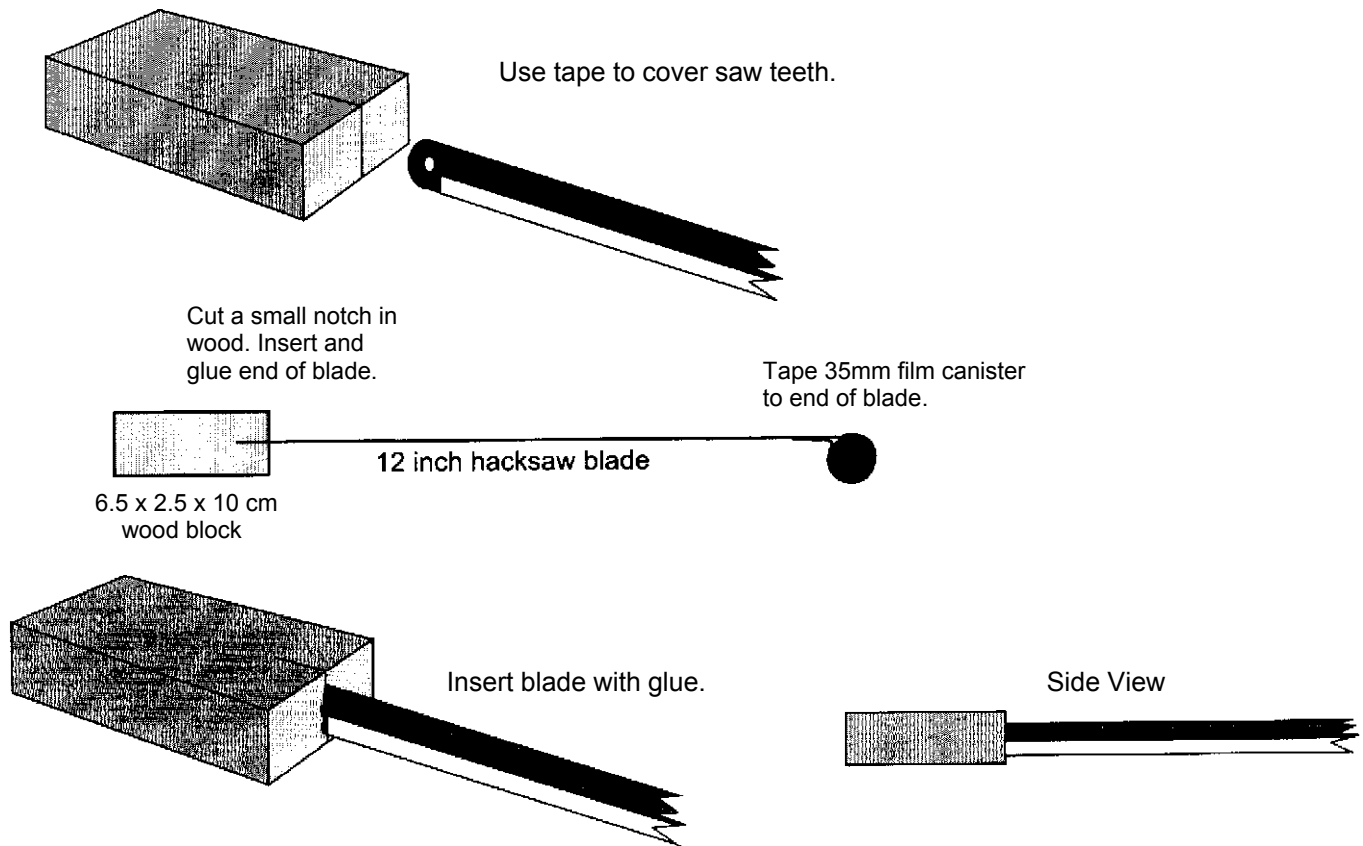
Construct Inertial Balances:

Before doing this activity, you will need to construct enough inertial balances for the entire class. Plan on having one balance for every three or four students. Except for the empty film canisters, which are free from photo processors, materials and tools for making all the balances can be obtained at a hardware store where lumber is also sold. To reduce your cost, buy hacksaw blades in multi packs. The dimensions for the wood blocks are not critical and you may be able to find a piece of scrap lumber to meet your needs. The only tools needed to construct the balances are a crosscut or backsaw to cut the wood into blocks and a coping saw to cut the notch for insertion of the blade. If you have access to power tools, use a table scroll saw to cut the notches. If the notches are too wide, select a thinner blade for the coping or scroll saw.

Cut the blocks, one for each balance, about 10 centimeters long. Cut a 2-centimeter deep notch in one end of each block. Slip one end of the hacksaw blade into the notch to check the fit. It should be snug. Remove the blade and apply a small amount of glue to both sides of the end and slip the blade back in place. Make sure the blade is slightly above and parallel to the bottom flat side of the block. Set the balance aside to dry.

Use tape to attach a film canister to the opposite end of each balance. Squirt hot glue into the bottom of the canister and drop in a large metal washer. Repeat two more times. The reason for doing this is to provide extra mass to the canister end of the inertial balance. Students will be counting how long it takes the device to oscillate from side to side 25

times. A very light canister will swing faster than the students can count. Extra mass will slow the device so that counting is possible.



Using the Inertial Balance:

To use the inertial balance, students will place the wood block on the edge of a table so the hacksaw and canister stick over the edge. The balance can be anchored with a clamp or just pressed to the tabletop by one student in the team. An object of unknown mass is placed in the canister and the students determine its mass by deflecting the blade so it swings from side to side. Unknown masses can be such things as nuts and bolts, washers, and pebbles. The tissue paper called for in the instructions anchors the unknown object in the canister so it will not slosh around and throw off the accuracy.

The first step for students is to calibrate the balance. This is done with a standard mass such as a penny. The length of time the balance takes to oscillate 25 times is measured for zero through ten pennies. The results are plotted on a graph. When an unknown mass is placed in the canister its time will be measured. By referring to the graph, students will be able to determine the unknown object's mass by seeing where it falls on the graph. The mass will be given in units of pennies. If desired, the balance can be calibrated in grams by measuring the pennies on a metric beam balance.

Assessment:

Collect calibration graphs and data sheets.

Inertial Balance Activity



The microgravity environment of an orbiting Space Shuttle or space station presents many research problems for scientists. One of these problems is measurement of mass. On Earth, mass measurement is simple. Samples, such as a crystal, or subjects, such as a laboratory animal, are measured on a scale or beam balance. In a scale, the object being measured compresses springs. The amount of compression tells what the object's weight is. (On Earth, weight is related to mass. Heavier objects have greater mass.) Beam balances, like a seesaw, measure an unknown mass by comparison to known masses. With both these devices, the force produced by Earth's gravitational attraction enables them to function.

In microgravity, scales and beam balances don't work. Setting a sample on the pan of a scale will not cause the scale springs to compress. Placing a subject on one side of a beam balance will not affect the other side. This causes problems for researchers. For example, a life science study on the nutrition of astronauts in orbit may require daily monitoring of an astronaut's mass. In materials science research, it may be necessary to determine how the mass of a growing crystal changes daily. How can mass be measured without gravity's effects?

Mass can be measured in microgravity by employing inertia. Inertia is the property of matter that causes it to resist acceleration. If you have ever tried to push anything that is heavy, you know about inertia. Imagine trying to push a truck. You will quickly realize that the amount of inertia or resistance proportional to the object's mass. An object with a greater mass has a greater inertia. By directly measuring an object's inertia in microgravity, you are indirectly measuring its mass.

The device employed to measure inertia and, thereby, mass is the inertial balance. It is a spring device that vibrates the subject or sample being measured. The object to be measured is placed in the sample tray or seat and anchored. In microgravity, the frequency of the vibration will vary with the mass of the object and the stiffness of the spring (in this activity, the hacksaw blade). An object with greater mass will vibrate more slowly than an object with less mass. The time needed to complete a given number of cycles is measured, and the mass of the object is calculated.

Inertial Balance Activity

Measuring Mass With Inertia

Calibrating the Inertial Balance:

1. Clamp the inertial balance to the table so the spring (saw blade) and sample bucket extends over the edge of the table.
2. Pick one member of your team to be the timekeeper, another to record data, and another to count cycles.
 - a) **Counter:** Pull the sample bucket a few centimeters to one side and release it. At the moment of release, say "Now" and begin counting cycles. A cycle is completed when the sample bucket starts on one side, swings across to the other and then returns to its starting point. When 25 cycles are complete, say, "Stop."
 - b) **Timer:** Time the number of cycles being counted to the nearest tenth of a second. Start timing when the counter says "Now" and stop when the counter says, "Stop."
 - c) **Recorder:** Record the time for 25 cycles as provided to you by the timer. There will be 11 measurements. Plot the measurements on the graph and draw a line connecting the points.
3. Begin calibration by inserting a wad of tissue paper in the bucket and deflecting the spring. Release the bucket and start counting cycles. When the time for 25 cycles is completed, enter the number in the data chart and plot the point on the graph for zero pennies. To improve accuracy, repeat the measurements several times and average the results.
4. Insert 1 penny into the bucket next to the tissue paper wad and measure the time it takes for 25 cycles. Record the data as 1 penny.
5. Repeat the procedure for 2 through 10 pennies and record the data.
6. Draw a line that goes through or close to all points on the graph. Your inertial balance is calibrated.

Using the Inertial Balance:

1. Place an unknown object in the inertial balance bucket. Remember to use the same tissue paper for stuffing. Measure the time for 25 cycles. And record your answer.
2. Starting on the left side of the graph, find the number of seconds you measured in step 1. Slide straight over to the right until you reach the graph line you drew in the previous activity. From this intersection point, go Straight down to the penny line. This will tell you the mass of the unknown object in pennyweights.
3. Repeat this process for four unknown objects.

Student Activity

Inertial Balance Activity

Measuring Mass with Inertia - Data Worksheet

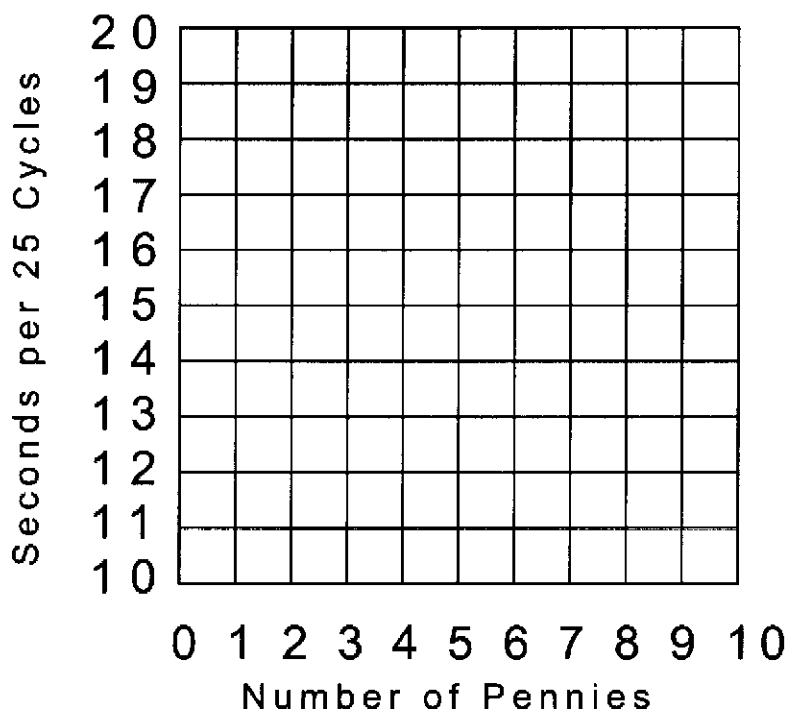
Measurement Team:

Counter: _____

Timer: _____

Recorder: _____

Calibration Graph



Unknown Object 1

Mass: _____ pw

Unknown Object 3

Mass: _____ pw

Unknown Object 2

Mass: _____ pw

Unknown Object 4

Mass: _____ pw

Inertial Balance Activity

Measuring Mass with Inertia - Questions Worksheet

1. Will this technique for measuring mass work in microgravity? Yes ____ No ____
Explain your answer:

2. Why was it necessary to use tissue paper for stuffing?

3. How could you convert the pennyweight measurements into grams?

4. Would the length of the hacksaw blade make a difference in the results?

5. What are some of the possible sources of error in measuring the cycles?

6. What does a straight line in the calibration graph imply?

Activity – Observe the Properties of Water in a Gravity Environment

You will be observing the properties of water in a gravity environment. Record your observations by writing a description and drawing a picture of what you observe. In addition, you should include the answers to the questions below. You will report your findings during the video conferencing event with NASA.

Materials:

- Two containers of different shapes for holding water
- Water with red food coloring

Directions/Questions:

1. Fill one of the containers with water.

A) What is the shape of the water?

B) Describe the surface of the water. Is it different near the edges of the container?

C) What is the shape of the water when there is no container?

2. Place the container of water over the empty container and pour the water from one container to the other.

A) What happens to the water when you turn the container upside down?

B) In the new container, what is the shape of the water?

C) Describe the surface of the water. Is it different near the edges of the container?

3. Imagine performing the same activities on the International Space Station. Predict what will happen to the water. Describe your prediction in words and by drawing a picture.

Activity – Observe the Properties of a Candle Flame in a Gravity Environment

You will be observing the properties of a candle flame in a gravity environment. Record your observations by writing a description and drawing a picture of what you observe. In addition, you should include the answers to the questions below. You will report your findings during the video conferencing event with NASA.

Materials:

- Candle
- Matches or lighter
- Candleholder
- Aluminum foil or nonflammable plate

Directions/Questions:

1. Place the candle in the candleholder. Place the candleholder on aluminum foil or a nonflammable surface.

2. Observe the flame. Draw a picture showing your observations.

A) What is the shape of the flame?

B) What colors are present?

3. Lift the candle and turn it sideways. Draw a picture showing your observations.

A) What is the shape of the flame?

B) What colors are present?

4. Imagine performing the same activities on the International Space Station. Predict what will happen to the flame. Describe your prediction in words and by drawing a picture.

Activity for follow-up during DLO event

Ball & Cup

Toy Construction

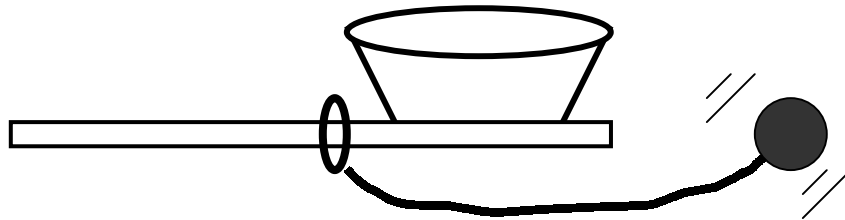
Making a Ball and Cup

Materials:

- Scissors
- Ruler
- Plastic spoon or Popsicle stick
- Two pieces of kite string about 2 feet (60 cm) in length
- Paper cup
- Ping pong ball
- Tape

Construction:

1. Place the Ping-Pong ball inside the cup. The cup should be just slightly larger than the Ping-Pong ball. If the cup is taller than the ball, trim it down until the ball just fits in the cup. The smaller the cup, the more challenging your toy will be.
2. Tape the spoon (or Popsicle stick) to the bottom of the cup with the bowl curved upward. The spoon handle is the handle of your new toy.
3. Tape one end of the kite string to the Ping-Pong ball, and tie the other to the handle of the spoon at a point near the cup. Wrap the string around the handle until the ball and cup are about 1 foot (30cm) apart.



Operation

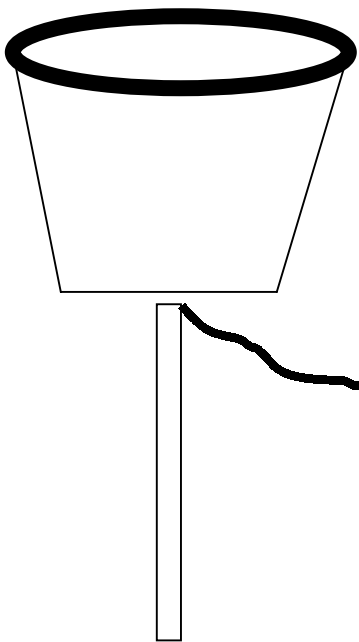
1. Hold the handle with one hand and let the ball hang down. With a swinging motion, cause the ball to swing into the cup. It must stay in the cup and not bounce out.
2. If you are having difficulty, wrap up more of the string. If it is too easy for you, make the string longer.
3. Try different techniques in playing with the ball and cup. Place the ball in the cup. Push the cup upward and then pull it downward. Watch what happens to the ball. Then push the cup back up to catch the falling ball.

Ball & Cup

Experiment on Earth Strings Attached

1. Hold the cup in one hand.
2. Give the cup a swinging motion that causes the ball to swing upward.
3. Try to catch the ball in the cup.
4. Ask your teammates to draw the path of the ball and to make suggestions about how to catch the ball.
5. Write down a description of how to swing the ball into the cup. Make a drawing to go with your description.

Drawing of ball's path into the cup.



How to catch the ball:

1. What force pulls the ball into the cup?
2. What keeps the ball in the cup after it is caught?

Ball & Cup

Experiments on Earth Strings Attached

Purpose: To determine the effect of the string's length in catching the ball in the cup

Materials:

- Ball and cup toy
- Ruler

Procedure:

1. Wind the string around the handle until the ball just reaches the cup.
2. Try catching the ball in the cup. Record how many tries are needed.
3. Unwind the string one turn and try to catch the ball again. Record the number of tries required.
4. Continue with this procedure until the string is unwound. Record your data.

Data:

Length of String From Ball to Handle	Times Required to Get Ball into Cup

1. Why is the length of the string important in the ball and cup?
2. Is there any advantage to a shorter string in space?

NASA Event Guidelines

Review the following points with your students prior to the event:

1. A video teleconference is a two-way event.
Students and NASA presenters can see and hear one another.
2. Students are representing their school; they should be on their best behavior.
3. Students should be prepared to give brief presentations, ask questions and respond to the NASA presenters.
4. A Teacher(s) or other site facilitator should moderate students' questions and answers.
5. Students should speak into the microphone in a loud, clear voice.

**Get Ready, Be Ready, and have fun with your
Distance Learning Event with NASA!**

Post Event Follow Up

1. For any follow-up questions from the event, please contact us at: DLO1@jsc.NASA.gov
2. We want to know where we excel and where we have room for improvement. Your candid and thoughtful reply will help our evaluation. Most people are able to complete the questionnaire in less than 10 minutes. Your response and any comments will be treated with utmost confidentiality. We welcome any input that you have at the following sites:
 - Teacher Feedback Form:
https://ehb2.gsfc.nasa.gov/edcats/centers/distance_learning.html
 - Student 4-12 Feedback Form:
https://ehb2.gsfc.nasa.gov/edcats/centers/dlo_412_student.html
 - Technical Contact Feedback Form:
https://ehb2.gsfc.nasa.gov/edcats/centers/jsc_dlo_tech_contact.html
 - Parent/Chaperone Feedback Form:
https://ehb2.gsfc.nasa.gov/edcats/centers/distance_learning_parent.html
3. Please send us any photos, video, link to your school's/organization's webpage, newspapers articles, etc. of your event and we will be glad to post them on our webpage!

Extended Activities for Microgravity

1. Perform additional activities found in the Teacher's Guide on Microgravity:
<http://spacelink.nasa.gov/Instructional.Materials/NASA.Educational.Products/Microgravity/Microgravity.Teachers.Guide.pdf>.
2. Team with a university to help with an experiment on the KC-135 Aircraft:
<http://microgravityuniversity.jsc.nasa.gov>
3. Perform further research on the Internet about the following areas of microgravity research:
<http://microgravity.msfc.nasa.gov/>.